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Effect of Anatomical location of fat on quality attributes of Beef kofta during freezing storage

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Abstract

A three trials based experiment were designed to investigate the effect of incorporate of fat from different anatomical location (subcutaneous, mesenteric and kidney fat) on the quality attributes of beef kofta during storage at -18°C for 3 months.

Anatomical location of carcass fat had slight effect on sensory quality of raw and cooked kofta with samples produced with subcutaneous fat had slightly higher scores than that produce with mesenteric fat and kidney fat. Moreover, freezing storage at -18°C for 12 weeks induced slight decrease in all sensory parameters. Proximate chemical analysis showed non-significant differences in moisture, fat, protein and ash contents. Also indicated that frozen storage resulted in slight but non-significant loss of moisture with subsequent increase in protein, fat and ash contents. The data as well showed that cooking loss was higher in kofta produced with subcutaneous fat (low saturated fatty acids) than that produced with mesenteric and kidney fats (high saturated fatty acids) which need higher temperature to be melted. Deterioration criteria revealed that frozen storage resulted in steady and slight non-significant increase in the pH, TVBN and TBA values for all formulations. Also bacteriological analysis showed that freezing storage induced slight effect on investigated bacteria in all formulations, where total aerobic mesophilic bacteria generally increased with varying rates, while the coliforms and staphylococci counts decreased in nearly all treatments at the end of storage period. Fatty acids profile of the 3 formulations cleared that subcutaneous fats had the lowest saturated fatty acid content. It could be concluded that subcutaneous fats considered the best type to be used in meat kofta processing.

Key wards: kofta, Meat ball, quality attributes, fatty acid profile, carcass fat

Introduction

Lipids play an important role in ground meat products, making them more desirable by improving the organoleptic properties of flavor, color and texture. In addition, they confer nutritive value on the product, constituting a source of metabolic energy, essential fatty acids and fat-soluble vitamins. On the other hand, the lipid components are susceptible to attack by molecular oxygen, resulting in lipid oxidation with the generation of compounds potentially harmful to human health. Moreover, lipid oxidation is a major cause of deterioration in the quality of such products ***(Ladikos and Lougovois, 1990)***, and the rate and degree of autoxidation degradation has been directly related to the degree of unsaturation of the lipids present (***Tichivangana and Morrissey, 1985)***.

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In general, meat products such as sausage, frankfurter, salami, hamburger and meatballs contain high levels of cholesterol, total lipid and saturated fatty acid contents which is linked with increased risks obesity, chronic heart diseases, cancer and stroke *(CDC, 2005)*. Therefore, consumption of meat products must be limited to prevent these diseases.

Many concerns has been raised over public health aspects of fats in meat products, in particular saturated fatty acids, which can highly expose to the risk of cardiovascular diseases and some type of cancer ***(Stender et al., 2006; Kraft et al., 2011)***. Moreover, lipid oxidation resulted in generation of compounds potentially harmful to human health.

Recently, there has been a tendency for consuming meat products among the Egyptian consumers due to continuous changes in the life style. Beef meatball have become one of the choices that fulfill consumer's demands due to thier high protein and carbohydrate content. Therefore, this study was conducted to assess the quality attributes of Egyptian kofta (Sensory, Chemical, Physicochemical, Bacteriological and Fatty acid profile) by adding fat from different anatomical location of carcass.

Materials and Methods

1. Beef kofta processing:

A three trials based experiment were designed to investigate the effect of incorporate of fat from different anatomical locations (subcutaneous, mesenteric and kidney fat) on the different quality attributes of beef kofta during storage at -18°C for 3 months. Three samples from each trial was investigated each 2 weeks interval for successive 3 months during storage at -18 C^0.

Three beef kofta batters were prepared using the same ingredient with the only difference was the use of fat from different anatomical locations (subcutaneous, intestinal and kidney) in each experiment. Beef kofta was prepared using 70% beef, 10% beef fat, 5% bread crumbs, 1.70% common salt, 0.3% sodium tripolyphosphate, 1% isolated soy proteins, 11% cool iced water, in addition to 1% mixed wild spices. Frozen minced beef was transferred to a paddle mixer, where common salt, polyphosphates, and seasonings were added to the ground meat while mixing. Afterwards cold water was incorporated during mixing and finally bread crumb was added. The batter was formed into of equal portions of 10 cm length and 2 cm diameter by manual stuffer. Each type of formed beef kofta was packed separately in closed polyethylene bags and kept frozen at -18°C till investigation.

2. Investigations

2.1. Sensory examination

Sensory evaluation of raw kofta samples (color, odor, marbling, forming and overall acceptability) and sensory evaluation of cooked kofta (flavor, juiciness, tenderness, palatability, overall acceptability) were assessed according to **El-Mogali et al. (1995).**

2.2. Chemical examinations

2.2.1. Proximate chemical analysis Moisture %, protein %, ether extractable fat %, ash %) were evaluated according to **AOAC (1995).**

2.2.2. Deterioration criteria

The pH value **(Kandeepan et al., 2009),** thiobarbituric acid reactive substance **(Du and Ahu, 2002)** and total Volatile Bases Nitrogen **(Kearsley et al., 1983).**

2.3. Physicochemical characteristics

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Cooking yield % **(Pinero et al., 2008)**, Moisture retention % **(EL-Magoli et al., 1995)**, Fat retention % **(Murphy et al., 1975)**, Diameter reduction % and Shrinkage % **(Serdaroglu and Degirmencioglu, 2004)**, Water Holding Capacity % **(Hongsprabhas and Barbut, 1999).**

2.4. Bacteriological examination (APHA, 1992)

After preparation of samples homogenate, the samples were analyzed for enumeration of Aerobic plate count, Coliform counts, presumptive *S. aureus* count, isolation and identification of *S.aureus*.

2.5. Fatty acid analysis. (AOAC 1995).

2.6. Statistical analysis the data were statistically analyzed according to **(SAS Institute 1996).**

Results and Discussion

Results of sensory panel analysis of beef kofta produced with fat from different anatomical locations (Tables 1and 2) showed slight non-significant differences in all investigated sensory attributes in both raw and cooked samples with samples produced with subcutaneous fat had slightly higher scores followed by that produce with mesenteric fat and finally that produced with kidney fat i.e. anatomical location of carcass fat had slight effect on sensory quality of frozen meat products. Moreover, freezing storage at -18°C for 12 weeks induced slight decrease in all sensory parameters.

Proximate chemical analysis of experimentally kofta produced with different types of fat immediately after processing (Tables 3) showed non-significant differences in moisture, fat, protein and ash contents. The results also indicated that frozen storage resulted in slight but non-significant loss of moisture with subsequent increase in protein, fat and ash contents. However, ***Rahardiyan and Brawijaya (2004)*** reported higher mean values for moisture and lower fat values of beef meatballs immediately after processing with significant decrease in moisture and increase in fat through three months of frozen storage.

Deterioration criteria of experimentally formulated kofta samples (Table 4) revealed that, initial mean levels of pH of experimentally formulated kofta with different anatomical fat ranged from 5.96- 5.99. However, frozen storage resulted in steady and slight non-significant increase in the pH values for all formulations. At the end of the three months of frozen storage period, the mean values reached 6.1, 6.08 and 6.1 for beef kofta formulated with subcutaneous, mesenteric and kidney fat; respectively.

The values of TVBN immediately after formulation of kofta were obviously low in all formulations. The mean values were 6.25, 6.16 and 6.72 mg/100g for samples formulated with subcutaneous, mesenteric and kidney fat, respectively. It was also clear that during frozen storage the values significantly increased with storage time to reach values generally lower than those established by the Egyptian Specifications (1973/2005). ***Mohammed (2002)*** reported that the mean TVBN in beef kofta increased from 11.3 initially to 14.9 *(mg/g)* at the end of storage at 18°C for 12 weeks.

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The initial mean values of thiobarbituric acid calculated as mg malonoldehyde /kg immediately were 0.22, 0.22 and 0.24 mg/kg 100g for Beef kofta formulated with subcutaneous, mesenteric and kidney fat, respectively. (Tables 4). Moreover, there was slight and steady increase in the values with frozen storage along storage period, where the values reached finally to 0.41, 0.42 and 0.4 mg/kg. *Mohammed (2002)* found that TBA of beef kofta increased significantly from 0.1 to 0.43 (mg/g) at the end of 12 weeks of storage -18°C. While *Rahardiyan and Brawijaya (2004)* reported mean TBA values of 2.54, 2.47 and 2.43 mg/kg at the 1st, 2nd and 3rd months of storage respectively. However, *Serdaroglu et al. (2005)* mentioned that TBA value of beef kofta at zero day, 1st , 2nd and 3rd month of frozen storage ranged between 0.63:0.82, 1.02:1.88, 1.55:2.11 and 1.99:2.88; respectively.

Data of water holding capacity (Table 5) showed that beef kofta produced with different types of fats had generally high water holding capacity with slight non-significant differences between the three treatments. Frozen storage, however, induced significant decrease in mean values of water holding capacity in the 2nd week of storage in samples produced with subcutaneous fat and from the 3rd week in other treatments. The product produced with kidney fat had the lowest value at the end of three months frozen storage. The obtained results were in agreement with those reported by *Farouk et al. (2004)* who found that water holding capacity of beef kofta tended to decrease gradually with time up to 3 months of frozen storage and attributed this decrease to the partial denaturation of protein and loss of its ability to hold up water with advance of frozen storage.

Cooking yield is an important data that is used by the meat industry to predict the behavior of their products during processing ***(Ulu, 2006)***. Data of cooking characteristics for experimentally produced kofta was summarized in (Tables 5). The mean values ranged from 18-22% initially after production and 20-24% at the end of storage time. However, ***Said (1997)*** found that 36.6% of the samples had cooking loss higher than 25%. The data also showed that cooking loss was higher in kofta produced with subcutaneous fat (low saturated fatty acids) than that produced with mesenteric and kidney fats (high saturated fatty acids) which need higher temperature to be melted. Animal's fats melt between about 25°C and 50°C as saturated fatty acids melting at higher and polyunsaturated fatty acids at lower temperatures ***(Warris, 2000)***.

Results of cooking loss percentages may be explained on the data for moisture retention and fat retention where samples produced with subcutaneous fat showed lower mean values initially and at the end of storage period in comparison with those produced with other types of fats. Moreover, the data also indicated that samples produced with subcutaneous fat had significantly lower diameter reduction and shrinkage %. This result

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was in agreement with those reported by ***Serdaroglu and Degirmencioglu (2004) and Ulu (2006).*** On the other hand, frozen storage for three months exerted a significant effect on all cooking quality characteristics.

Bacteriological analysis of experimentally formulated kofta immediately after processing (Tables 6) showed that, the mean aerobic plate, coliforms and presumptive *Staph. aureus* (log_{10} *CFU/g*) for kofta with subcutaneous fat were 4.36, 2.85 and 1.43, respectively. However, mean values of 4.31, 2.88 & 2.7 and 4.53, 2.88 & 2.5 were recorded for kofta produced with mesenteric and kidney fat respectively. Freezing storage induced slight effect on investigated bacteria in all formulations, where total aerobic mesophilic bacteria generally increased with varying rates during three months of frozen storage at -18°C, while the coliforms and staphylococci counts decreased to below the detection limit in nearly all treatments at the end of storage period. However, ***Mohammed (2002)*** found that, the average count of total aerobic at the beginning of storage of kofta was 5.8 and increased by the end of storage to reach 6 log_{10} CFU/g, while ***Awad (2003)*** found that, the initial counts for mesophilic bacteria ranged from 3.3×10^2 to 1.8×10^4 CFU/g which increased gradually during storage.

Fatty acids profile of the 3 experimentally produced kofta formulations (Table 7) showed that, total saturated, monounsaturated and polyunsaturated fatty acids of kofta with subcutaneous fat was 54.38, 38.85 and 2.88 compared to 57.42, 33.25 and 2.52 for kofta with mesenteric fat and 55.42, 37.08 and 2.45 for kofta with kidney fats, respectively.

Fatty acid composition of meat determines the firmness/oiliness of adipose tissue and the oxidative stability of further processed meat products during processing and retail display, which affects flavor and acceptability of meat products ***(Wood et al., 2008).*** Saturated fats, due to their fatty acid composition and lower melting temperature, contribute a major amount to the texture, mouth feel, juiciness and overall sensory acceptability of finely comminuted and ground meat products ***(Wood, 2013).*** The obtained data substinated the aforementioned facts, where the product formulated with kidney fat (high saturated fatty acids) had generally lower sensory panel quality either in raw or cooked samples, slightly more stable fat (Low TBA), higher eating quality characteristics (low cooking loss, high moisture retention and fat retention percentages) followed by those produced with mesenteric fat and finally that of subcutaneous fat.

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Table (1): Mean sensory panel score of experimentally produced raw kofta stored at -18°C for 12 weeks

	0	2	4	6	8	10	12
				Color/wk.			
Subcutaneous	$_{i}4.8^{a}\pm0.1$	$_{i,ii}4.7^{a}\pm0$	$_{ii,iii}4.4^{a}\pm0.133$	$_{iii,iv}4.2^{a}\pm0.1$	$_{iv,v}4^{a}\pm0.17$	$_{v}3.8^{a}\pm0.1$	$_{v}3.7^{a}\pm0$
Mesenteric	$_{i}4.7^{a}\pm0$	$_{i,ii}4.4^{a}\pm0.133$	$_{ii}4.2^{a}\pm0.1$	$_{ii,iii}4.1^{a}\pm0.1$	$_{iii}3.9^{a}\pm0.2$	$_{ii,iii}3.7^{a}\pm0$	$_{iv}3.3^{a}\pm0.3$
Kidney	$_{i}4.6^{a}\pm0.133$	$_{i,ii}4.4^{a}\pm0.133$	$_{i,ii,iii}4.2^{a}\pm0.1$	$_{ii,iii,iv}4.1^{a}\pm0.1$	$_{iii,iv}4^{a}\pm0.17$	$_{v}3.8^{a}\pm0.1$	$_{v}3.6^{a}\pm0.13$
				Flavor/wk.			
Subcutaneous	$_{i}4.8^{a}\pm0.1$	$_{i}4.7^{a}\pm0$	$_{ii}4.4^{a}\pm0.133$	$_{ii}4.3^{a}\pm0$	$_{iii}4^{a}\pm0$	$_{iv}3.4^{a}\pm0.133$	$_{v}3^{a}\pm0$
Mesenteric	$_{i}4.6^{a}\pm0.133$	$_{i}4.4^{a}\pm0.133$	$_{ii}4.3^{a}\pm00$	$_{ii}4.1^{a}\pm0.1$	$_{iii}4^{a}\pm0$	$_{iii}3.8^{a}\pm0.1$	$_{iii}3.3^{a}\pm0.2$
Kidney	$_{i}4.7^{a}\pm0$	$_{i,ii}4.4^{a}\pm0.133$	$_{i,ii,iii}4.2^{a}\pm0.1$	$_{ii,iii,iv}4.1^{a}\pm0.1$	$_{iii,iv}3.7^{a}\pm0.2$	$_{iv}3.2^{a}\pm0.233$	$_{v}2.9^{a}\pm0.1$
				Overall acceptability/wk.			
Subcutaneous	$_{i}4.9^{a}\pm0.1$	$_{i}4.7^{a}\pm0$	$_{i,ii}4.4^{a}\pm0.133$	$_{ii,iii}4.2^{a}\pm0.1$	$_{iii,iv}3.9^{a}\pm0.1$	$_{iv,v}3.6^{a}\pm0.133$	$_{v}3.3^{a}\pm0.2$
Mesenteric	$_{i}4.8^{a}\pm0.1$	$_{ii,iii}4.4^{a}\pm0.133$	$_{iii,iv}4.2^{a}\pm0.1$	$_{iv,v}4.0^{a}\pm0$	$_{v,vi}3.8^{a}\pm0.1$	$_{vi,vii}3.7^{a}\pm0$	$_{vii}3.4^{a}\pm0.13$
Kidney	$_{i}4.9^{a}\pm0.1$	$_{i}4.6^{a}\pm0.133$	$_{ii}4.3^{a}\pm0$	$_{ii}4.1^{a}\pm0.1$	$_{ii}3.8^{a}\pm0.1$	$_{iii}3.2^{a}\pm0.233$	$_{iii}3.0^{a}\pm0$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05

Table (2): Mean sensory panel score of experimentally produced cooked kofta stored at -18c for 12 weeks:

	0	2	4	6	8	10	12
				Flavor/wk.			
Subcutaneous	$_{i}4.9^{a}\pm0.1$	$_{i}4.8^{a}\pm0.1$	$_{ii}4.3^{a}\pm00$	$_{iii}4^{a}\pm00$	$_{iii,iv}3.8^{a}\pm0.1$	$_{iv}3.6^{a}\pm0.133$	$_{v}3.3^{a}\pm0$
Mesenteric	$_{i}4.7^{a}\pm0$	$_{i}4.6^{a}\pm0.133$	$_{i}4.4^{a}\pm0.133$	$_{ii}4.1^{a}\pm0.1$	$_{ii}3.8^{a}\pm0.1$	$_{ii}3.8^{a}\pm0.1$	$_{iii}3.4^{a}\pm0.133$
Kidney	$_{i}4.8^{a}\pm0.1$	$_{i,ii}4.6^{a}\pm0.133$	$_{ii,iii}4.3^{a}\pm0$	$_{iii}4.1^{a}\pm0.1$	$_{iv}3.8^{a}\pm0.1$	$_{iv}3.6^{a}\pm0.133$	$_{iv}3.3^{a}\pm0$
				Juiciness/wk.			
Subcutaneous	$_{i}4.9^{a}\pm0.1$	$_{i,ii}4.8^{a}\pm0.1$	$_{ii}4.6^{a}\pm0.133$	$_{iii}4.2^{a}\pm0.1$	$_{iii}4^{a}\pm0$	$_{iv}3.6^{a}\pm0.133$	$_{v}3.1^{a}\pm0.1$
Mesenteric	$_{i}4.8^{a}\pm0.1$	$_{i,ii}4.7^{a}\pm0$	$_{ii}4.4^{a}\pm0.133$	$_{iii}4^{a}\pm0$	$_{iii}3.8^{a}\pm0.1$	$_{iv}3.4^{a}\pm0.133$	$_{v}3.1^{a}\pm0.1$
Kidney	$_{i}4.7^{a}\pm0$	$_{i}4.7^{a}\pm0$	$_{i}4.4^{a}\pm0.133$	$_{ii}4.1^{a}\pm0.1$	$_{iii}3.8^{a}\pm0.1$	$_{iii}3.6^{a}\pm0.133$	$_{iv}3.2^{a}\pm0.1$
				Tenderness/wk.			
Subcutaneous	$_{i}4.9^{a}\pm0.1$	$_{i}4.8^{a}\pm0.1$	$_{ii}4.3^{a}\pm0$	$_{ii,iii}4.2^{a}\pm0.1$	$_{iii}3.9^{a}\pm0.1$	$_{iv}3.6^{a}\pm0.133$	$_{iv}3.3^{a}\pm0$
Mesenteric	$_{i}4.8^{a}\pm0.1$	$_{i,ii}4.6^{a}\pm0.133$	$_{ii,iii}4.4^{a}\pm0.133$	$_{iii,iv}4.2^{a}\pm0.1$	$_{iv}4^{a}\pm0$	$_{v}3.6^{a}\pm0.133$	$_{v}3.3^{a}\pm0$
Kidney	$_{i}4.7^{a}\pm0$	$_{i,ii}4.3^{a}\pm0.133$	$_{ii,iii}4.2^{a}\pm0.1$	$_{iii,iv}4^{a}\pm0$	$_{iv,v}3.7^{a}\pm0.2$	$_{v}3.4^{a}\pm0.133$	$_{vi}3.2^{a}\pm0.1$
				Palatability/wk.			
Subcutaneous	$_{i}5^{a}\pm0$	$_{ii}4.7^{a}\pm0$	$_{ii,iii}4.4^{a}\pm0.133$	$_{iii,iv}4.1^{a}\pm0.1$	$_{iv}4^{a}\pm0$	$_{v}3.6^{a}\pm0.133$	$_{vi}3^{a}\pm0.1$
Mesenteric	$_{i}4.9^{a}\pm0.1$	$_{i,ii}4.6^{a}\pm0.133$	$_{ii}4.4^{a}\pm0.133$	$_{ii,iii}4.2^{a}\pm0.1$	$_{iii,iv}3.9^{a}\pm0.1$	$_{iv,v}3.7^{a}\pm0$	$_{v}3.3^{a}\pm0.2$
Kidney	$_{i}4.9^{a}\pm0.1$	$_{i,ii}4.6^{a}\pm0.133$	$_{ii,iii}4.4^{a}\pm0.133$	$_{iii,iv}4.1^{a}\pm0.1$	$_{iv}3.9^{a}\pm0.1$	$_{v}3.4^{a}\pm0.133$	$_{v}3.1^{a}\pm0.1$
				Overall acceptability/wk.			
Subcutaneous	$_{i}4.9^{a}\pm0.1$	$_{i}4.8^{a}\pm0.1$	$_{ii}4.3^{a}\pm0$	$_{ii,iii}4.1^{a}\pm0.1$	$_{iii,iv}3.9^{a}\pm0.1$	$_{iv}3.7^{a}\pm0.21$	$_{v}3.1^{a}\pm0.1$
Mesenteric	$_{i}4.8^{a}\pm0.1$	$_{ii}4.4^{a}\pm0.133$	$_{iii,iv}4.3^{a}\pm0$	$_{iv}4^{a}\pm0$	$_{iv,v}3.9^{a}\pm0.1$	$_{v,vi}3.6^{a}\pm0.133$	$_{vi}3.3^{a}\pm0$
Kidney	$_{i}4.8^{a}\pm0.1$	$_{ii}4.4^{a}\pm0.133$	$_{ii,iii}4.2^{a}\pm0.1$	$_{iii,iv}4^{a}\pm0$	$_{iv}3.9^{a}\pm0.1$	$_{v}3.4^{a}\pm0.133$	$_{v}3.2^{a}\pm0.1$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05)

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2. Proximate chemical composition:

Table (3): Mean proximate chemical analysis for experimentally produced kofta stored at -18°C for 12 weeks

	0	2	4	6	8	10	12
				Moisture/wk.			
Subcutaneous	$_{i}59.3^{a}\pm.46$	$_{i,ii}59.11^{a}\pm0.37$	$_{i,ii}59.06^{a}\pm0.38$	$_{i,ii,iii}58.43^{a}\pm0.13$	$_{ii,iii}58.37^{a}\pm0.16$	$_{iii}58.11^{a}\pm0.13$	$_{iii}57.89^{a}\pm0.15$
Mesenteric	$_{i}59.56^{a}\pm0.23$	$_{i,ii}59.24^{a}\pm0.18$	$_{ii,iii}59^{a}\pm0.13$	$_{iii,iv}58.7^{a}\pm0.19$	$_{iv,v}58.43^{a}\pm0.18$	$_{iv,v}58.32^{a}\pm0.07$	$_{v}57.96^{a}\pm0.03$
Kidney	$_{i}59.41^{a}\pm0.183$	$_{i}59.04^{a}\pm0.2$	$_{ii}58.41^{a}\pm0.185$	$_{ii,iii}58.16^{a}\pm0.16$	$_{ii,iii}57.97^{a}\pm0.15$	$_{iii}57.8^{b}\pm0.103$	$_{iii}57.7^{a}\pm0.11$
				Fat/wk.			
Subcutaneous	$_{i}11.76^{a}\pm0.12$	$_{i,ii}11.78^{a}\pm0.30$	$_{i,ii}11.79^{a}\pm0.16$	$_{i,ii}11.88^{a}\pm0.12$	$_{i,ii}11.95^{a}\pm0.09$	$_{i,ii}12.16^{a}\pm0.21$	$_{ii}12.42^{a}\pm0.16$
Mesenteric	$_{i}11.67^{a}\pm0.04$	$_{i,ii}11.81^{a}\pm0.01$	$_{i,ii}11.93^{a}\pm0.03$	$_{ii}12.09^{a}\pm0.38$	$_{ii,iii}12.14^{a}\pm0.07$	$_{iii,iv}12.22^{a}\pm0.042$	$_{iv}12.28^{a}\pm0.04$
Kidney	$_{i}11.65^{a}\pm0.1$	$_{i,ii}11.74^{a}\pm0.04$	$_{ii,iii}11.85^{a}\pm0.02$	$_{iii,iv}12.07^{a}\pm0.061$	$_{iv,v}12.13^{a}\pm0.04$	$_{iv,v}12.19^{a}\pm0.03$	$_{v}12.24^{a}\pm0.03$
				Protein/wk.			
Subcutaneous	$_{i}15.5^{a}\pm0.12$	$_{i,ii}15.6^{a}\pm0.12$	$_{ii,iii}15.86^{a}\pm0.12$	$_{iii,iv}16^{a}\pm0.1$	$_{iii,iv}16.07^{a}\pm0.013$	$_{iv}16.15^{a}\pm0.023$	$_{iv}16.28^{a}\pm0.042$
Mesenteric	$_{i,ii}15.7^{a}\pm0.4$	$_{i}15.79^{a}\pm0.03$	$_{i,ii}15.9^{a}\pm0.01$	$_{i,ii}15.93^{a}\pm0.013$	$_{i,ii}16.08^{a}\pm0.13$	$_{i,ii}16.21^{a}\pm0.13$	$_{ii}16.34^{a}\pm0$
Kidney	$_{i}15.72^{a}\pm0.03$	$_{i}15.73^{a}\pm0.02$	$_{ii}15.9^{a}\pm0.01$	$_{ii}15.91^{a}\pm0.01$	$_{ii}15.95^{a}\pm0.013$	$_{ii}15.96^{a}\pm0$	$_{iii}16.21^{a}\pm0.13$
				Ash/wk.			
Subcutaneous	$_{i}2.21^{a}\pm0.08$	$_{i,ii}2.35^{a}\pm0.16$	$_{i,ii,iii}2.4^{a}\pm0.03$	$_{ii,iii,iv}2.49^{a}\pm0.06$	$_{ii,iii,iv}2.57^{a}\pm0.02$	$_{iii,iv}2.6^{a}\pm0.009$	$_{iii}2.68^{a}\pm0.103$
Mesenteric	$_{i}2.04^{a}\pm0.046$	$_{i,ii}2.12^{a}\pm0.06$	$_{ii,iii}2.18^{b,c}\pm0.01$	$_{iii}2.27^{b,c}\pm0.04$	$_{iii}2.28^{b,c}\pm0.03$	$_{iii}2.29^{b,c}\pm0.04$	$_{iv}2.44^{b,c}\pm0.024$
Kidney	$_{i}2.03^{a}\pm0.07$	$_{i,ii}2.09^{a}\pm0.05$	$_{ii,iii}2.21^{c}\pm0.08$	$_{ii,iii,iv}2.26^{c}\pm0.06$	$_{iii,iv}2.27^{c}\pm0.03$	$_{iii,iv}2.32^{c}\pm0.057$	$_{iv}2.41^{c}\pm0.03$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05)

3. Deterioration criteria:

Table (4): Mean deterioration criteria for experimentally produced kofta stored at -18°C for 12 weeks.

	0	*2*	*4*	*6*	*8*	*10*	*12*
				pH/wk.			
Subcutaneous	$_{i}5.99^{a}\pm0.012$	$_{i,ii}6.02^{a}\pm0.01$	$_{ii}6.04^{a}\pm0.01$	$_{iii}6.07^{a}\pm0.01$	$_{iii,iv}6.08^{a}\pm0.03$	$_{iii,iv}6.09^{a}\pm0.06$	$_{iv}6.1^{a}\pm01$
Mesenteric	$_{i}5.97^{a}\pm0.023$	$_{ii}6.01^{a}\pm0.01$	$_{ii,iii}6.03^{a}\pm0.03$	$_{ii,iii}6.04^{a}\pm0.01$	$_{iii,iv}6.05^{b}\pm0.008$	$_{iii,iv}6.06^{b}\pm0.003$	$_{iv}6.08^{b}\pm0.003$
Kidney	$_{i}5.96^{a}\pm0.035$	$_{ii}6.04^{a}\pm0.01$	$_{ii,iii}6.06^{b}\pm0$	$_{ii,iii}6.07^{a}\pm0.06$	$_{iii}6.08^{a}\pm0.003$	$_{iii}6.1^{a}\pm0.003$	$_{iii}6.13^{a}\pm0.03$
				TBA/wk.			
Subcutaneous	$_{i}0.22^{a}\pm0.004$	$_{i,ii}0.231^{a}\pm0.007$	$_{ii,iii}0.25^{a}\pm0.006$	$_{iii}0.26^{a}\pm0.012$	$_{iv}0.33^{a}\pm0.01$	$_{iv}0.34^{a}\pm0.005$	$_{v}0.41^{a}\pm0.01$
Mesenteric	$_{i}0.219^{a}\pm0.002$	$_{i,ii}0.23^{a}\pm0.007$	$_{ii}0.25^{a}\pm0.006$	$_{iii}0.28^{a}\pm0.004$	$_{iv}0.33^{a}\pm0.01$	$_{iv}0.34^{a}\pm0.008$	$_{v}0.42^{a}\pm0.01$
Kidney	$_{i}0.23^{a}\pm0.01$	$_{i,ii}0.24^{a}\pm0.023$	$_{ii}0.25^{a}\pm0.005$	$_{iii}0.28^{a}\pm0.02$	$_{iv}0.32^{a}\pm0.004$	$_{v}0.35^{a}\pm0.02$	$_{vi}0.4^{a}\pm0.012$
				TVBN/wk.			
Subcutaneous	$_{i}6.25^{a}\pm0.1$	$_{ii}6.72^{a}\pm0.2$	$_{ii}6.9^{a}\pm0.1$	$_{iii}7.65^{a}\pm0.1$	$_{iii,iv}8.03^{a}\pm0.1$	$_{iv}8.21^{a}\pm0.1$	$_{v}8.77^{a}\pm0.25$
Mesenteric	$_{i}6.16^{b}\pm0.22$	$_{i}6.25^{b}\pm0.24$	$_{ii}6.34^{a}\pm0.41$	$_{iii}6.8^{a}\pm0.47$	$_{iii}7.68^{b}\pm1$	$_{iii}8.03^{a}\pm0.2$	$_{iv}10.08^{b,c}\pm0.2$
Kidney	$_{i}6.72^{a}\pm0.2$	$_{i}6.9^{a}\pm0.1$	$_{i}7.2^{a}\pm0.1$	$_{ii}7.93^{a}\pm0.2$	$_{ii}8.03^{a}\pm0.1$	$_{iii}8.8^{a}\pm0.34$	$_{iv}10.3^{c}\pm0.2$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05)

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4. Physicochemical characteristics:

Table (5): Mean physicochemical criteria for experimentally produced kofta stored at -18°C for 12 weeks:

	0	2	4	6	8	10	12
				Cooking loss/wk			
Subcutaneous	$^{j}21.44^{a}\pm1.02$	$^{i,j}22.12^{a}\pm0.92$	$^{i,j,k}22.75^{a}\pm0.27$	$^{g,h}23.23^{a}\pm0.03$	$^{g,h}23.7^{a}\pm0.35$	$^{g}24^{a}\pm0.23$	$^{g}24.3^{a}\pm0.11$
Mesenteric	$^{i,j}19.75^{a}\pm0.85$	$^{j}19.75^{a}\pm0.85$	$^{i,j}20.27^{a}\pm0.90$	$^{i,j,k}21.76^{a}\pm0.491$	$^{g,h}21.85^{a,b}\pm1$	$^{g,h}22.24^{a}\pm0.5$	$^{g}22.4^{a}\pm0.5$
Kidney	$^{j}18.9^{a}\pm0.11$	$^{j}18.9^{a}\pm0.113$	$^{i,j}19.49^{a}\pm0.44$	$^{i,j,k}19.85^{b}\pm0.3$	$^{i,j,k}19.95^{b}\pm0.6$	$^{h,i}20.2^{c}\pm0.38$	$^{g,h}20.6^{c}\pm0.26$
				WHC/wk			
Subcutaneous	$^{j}93.14^{a}\pm0.20$	$^{j}91.94^{b}\pm0.4$	$^{g,h}90.38^{c}\pm0.3$	$^{e,f}88.75^{d}\pm0.24$	$^{f}87.19^{e}\pm0.40$	$^{e}85.62^{f}\pm0.3$	$^{d,e}83.96^{g}\pm0.296$
Mesenteric	$^{j}93.37^{a}\pm0.20$	$^{j}93.37^{a}\pm0.20$	$^{j}92.85^{b}\pm0.2$	$^{g}90.61^{c}\pm0.3$	$^{e}90.12^{d}\pm0.63$	$^{g}87.37^{e}\pm0.72$	$^{f}84.1^{g}\pm0.38$
Kidney	$^{j}92.94^{a}\pm0.16$	$^{j}92.94^{a}\pm0.16$	$^{j}92.19^{b}\pm0.3$	$^{g}90.04^{c}\pm0.2$	$^{e}88.74^{d}\pm0.34$	$^{f}86.8^{e}\pm0.66$	$^{f}83.61^{g}\pm0.71$
				Moisture retention/wk			
Subcutaneous	$^{j}40.24^{a}\pm0.55$	$^{g,h}39.12^{b}\pm0.46$	$^{a,b}38.69^{c}\pm0.16$	$^{a,b,c}38.38^{d}\pm0.1$	$^{a,b,c}37.94^{e}\pm0.293$	$^{c,d}37.62^{f}\pm0.27$	$^{c,d}37.36^{g}\pm0.23$
Mesenteric	$^{j}41.1^{a}\pm0.50$	$^{j}41.1^{a}\pm0.50$	$^{i,j}40.7^{b,c}\pm0.41$	$^{g,h}39.75^{d}\pm0.26$	$^{g}39.52^{d,e}\pm0.5$	$^{g,h}39.2^{b,c}\pm0.29$	$^{g,h}39^{b,c}\pm0.3$
Kidney	$^{j}41.57^{a}\pm0.13$	$^{j}41.57^{a}\pm0.13$	$^{j}41.17^{b}\pm0.2$	$^{g}40.64^{c}\pm0.12$	$^{g,h}40.32^{c}\pm0.22$	$^{g,h}40.06^{c}\pm0.25$	$^{g}39.7^{c}\pm0.1$
				Fat retention/wk			
Subcutaneous	$^{j}82.14^{a}\pm1.11$	$^{i,j}81.7^{a}\pm0.57$	$^{i,j}80.8^{a}\pm1.035$	$^{i,j}80.13^{a}\pm0.83$	$^{g}79.04^{b}\pm1.05$	$^{g}79^{b}\pm0.72$	$^{g}78.94^{b}\pm1.5$
Mesenteric	$^{j}87.38^{a,b}\pm1.80$	$^{j}87.38^{a,b}\pm1.80$	$^{j}86.74^{b,c}\pm0.88$	$^{i,j}84.5^{d,e}\pm0.26$	$^{g,h}83.47^{e,f}\pm1.3$	$^{g}82.9^{f,g}\pm0.86$	$^{g}82.6^{f,g}\pm0.83$
Kidney	$^{j}87.26^{a}\pm0.6$	$^{j}87.26^{a}\pm0.6$	$^{i,j}86.9^{a}\pm0.15$	$^{i,j}86.3^{a}\pm0.32$	$^{i,j}85.3^{b}\pm1.08$	$^{i,j}85.15^{b}\pm0.25$	$^{g,h}84.6^{c}\pm0.9$
				Diameter reduction/wk			
Subcutaneous	$^{j}11.76^{a}\pm0$	$^{i,j}12.14^{a}\pm0.39$	$^{i,j,k}12.52^{a}\pm0.39$	$^{i,j,k}12.94^{a}\pm0.68$	$^{i,j,k}12.94^{a}\pm0$	$^{g,h}13.3^{a}\pm0.4$	$^{g}13.7^{a}\pm0.39$
Mesenteric	$^{j}11.1^{a}\pm0.55$	$^{j}11.1^{a}\pm0.55$	$^{i,j}11.66^{a}\pm0$	$^{i,j,k}12.17^{a}\pm0.56$	$^{i,j,k}12.2^{a}\pm0.56$	$^{g,h,i}12.75^{a}\pm0.58$	$^{g,h}13.33^{a}\pm0$
Kidney	$^{j}11.06^{a}\pm0.32$	$^{j}11.06^{a}\pm0.32$	$^{i,j}11.61^{a}\pm0.22$	$^{i,j,k}11.99^{a}\pm0.04$	$^{h,i,j}12.31^{a}\pm0.36$	$^{g,h}12.56^{a}\pm0.48$	$^{g,h}13.2^{a}\pm0.09$
				Shrinkage percentage/wk			
Subcutaneous	$^{j}12.01^{a}\pm0.3$	$^{i,j}12.53^{a}\pm0.31$	$^{i,j,k}13.14^{a}\pm0.31$	$^{g,h,i}13.7^{a}\pm0.52$	$^{g,h,i}13.8^{a}\pm0$	$^{g,h}14.4^{a}\pm0.61$	$^{g}15^{a}\pm0.61$
Mesenteric	$^{j}11.8^{a}\pm0.01$	$^{j}11.8^{a}\pm0.01$	$^{i,j}12.27^{a}\pm0.44$	$^{i,j}12.71^{a}\pm0.9$	$^{i,j,k}13.15^{a}\pm0$	$^{g,h}13.6^{a,b}\pm0.45$	$^{g,h}13.63^{a}\pm0.45$
Kidney	$^{j}11.04^{a}\pm0.47$	$^{j}11.04^{a}\pm0.47$	$^{j}11.49^{a}\pm0.19$	$^{i,j}11.8^{a}\pm0.26$	$^{h,i,j}12.64^{a}\pm0.29$	$^{g,h}12.71^{b}\pm0.22$	$^{g,h}12.94^{a}\pm0.26$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05)

5. Bacteriological quality

Table (6): Mean bacterial load (log10 cfu/g) for experimentally produced kofta stored at -18°C for 12 weeks

	0	2	4	6	8	10	12
				APC/wk			
Subcutaneous	$^{j}4.36^{a}\pm0.1$	$^{g}4.54^{a}\pm0.05$	$^{c,d}4.64^{a}\pm0.052$	$^{a,b}4.68^{a}\pm0.02$	$^{b,c}4.76^{a}\pm0.01$	$^{a,b}4.88^{a}\pm0.01$	$^{a}4.94^{a}\pm0.014$
Mesenteric	$^{j}4.31^{a}\pm0.1$	$^{j}4.33^{a}\pm0.04$	$^{g}4.6^{a}\pm0.034$	$^{g}4.64^{a}\pm0.02$	$^{g}4.65^{a}\pm0.01$	$^{g}4.75^{b,c}\pm0.03$	$^{e}5.23^{d}\pm0.10$
Kidney	$^{j}4.53^{a}\pm0.1$	$^{j}4.6^{a}\pm0.02$	$^{j}4.7^{a}\pm0.1$	$^{c,d}4.89^{b}\pm0.03$	$^{c,d}4.9^{b}\pm0.025$	$^{j}4.9^{b}\pm0.02$	$^{g}5.3^{c}\pm0.36$
				Coliforms/wk			
Subcutaneous	$^{j}2.85^{a}\pm0.2$	$^{j}2.6^{a}\pm0.2$	$^{j}2.4^{a}\pm0.06$	$^{g}0.77^{a}\pm0.77$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$
Mesenteric	$^{c,d}2.88^{a}\pm0.21$	$^{j}2.8^{a}\pm0.06$	$^{j}2.72^{b,c}\pm0.12$	$^{j}2.7^{b,c}\pm0.2$	$^{c,d}2.52^{b,c}\pm0.042$	$^{c,d}2.2^{b,c}\pm0.10$	$^{g}2.1^{b,c}\pm0.1$
Kidney	$^{j}2.88^{a}\pm0.21$	$^{j}2.7^{a}\pm0.12$	$^{j}2.7^{a}\pm0.051$	$^{j}2.67^{a}\pm0.03$	$^{j}2.5^{a}\pm0.11$	$^{j}2.4^{a}\pm0.1$	$^{j}2.1^{a}\pm0.1$
				S. aureus/wk			
Subcutaneous	$^{j}1.43^{a}\pm0.7$	$^{g,h}0.67^{a}\pm0.67$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$
Mesenteric	$^{j}2.7^{a}\pm0.05$	$^{j}2.36^{b,c}\pm0.06$	$^{j}2.23^{b,c}\pm0.1$	$^{g,h}2.0^{b}\pm0$	$^{g}1.33^{b}\pm0.67$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$
Kidney	$^{g,h}2.5^{a}\pm0.87$	$^{j}2.3^{a}\pm0.14$	$^{g,h}2.11^{a}\pm0.1$	$^{c,d}1.43^{a,b}\pm0.72$	$^{g,h}0.67^{a}\pm0.67$	$^{g}<2.00^{a}$	$^{g}<2.00^{a}$

a-f: Mean with different superscript within the same row for each parameter differ significantly (P<0.05)
i-vii: Mean with different subscript within the same column for each parameter differ significantly(P<0.05)

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6. Fatty acide profile:

Table (7): Fatty acid analysis for expermentally produced kofta:

	Kofta with S/C fat	Kofta with mesenteric fat	Kofta with kidney fat
C12:0	0.06	0.09	0.06
C14:0	2.34	3.08	2.62
C16:0	23.8	24.60	22.92
C16:1	1.65	1.43	1.48
C17:0	1.44	0.51	0.52
C17:1	0.50	0.51	0.52
C18:0	26.39	28.68	29.01
C18:1	36.51	31.06	34.85
C18:2	2.62	2.16	2.17
C18:3	0.26	0.36	0.28
C20:0	0.30	0.28	0.29
C20:1	0.19	0.25	0.23
Total unknown %	3.89	5.81	4.01
Saturated fatty acid	54.33	57.42	55.42
Mono unsaturated fatty acid	38.85	33.25	37.08
Poly unsaturated fatty acid	2.88	2.52	2.45
Total unsaturated fatty acid	41.73	35.77	39.53

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الملخص العربى

في هذا الجزء من الدراسة تم الإنتاج التجريبي للكفته البقرى باستخدام دهون من اجزاء مختلفه من جسم الحيوان(تحت الجلد ,وبين الاعضاء, بيت الكلاوى). وقد تم حفظ المنتجات بعد تصنيعها عند -18م° وفحصها بعد التصنيع مباشرة ثم كل اسبوعين لمدة ثلاثة اشهر باستخدام معايير الجودة

أشار التحليل الكيماني للكفته المنتجة تجريبياً بأن الحفظ بالتجميد قد أثر تاثيراً غيرمعنوي علي محتوي الرطوبه و البروتين والدهن والرماد. وقد أظهرت النتائج الى انخفاض الرطوبة في جميع التجارب وبالتالى ارتفاع محتواها من الدهن والبروتين والرماد.

وقد دلت نتائج الفحص البكتريولوجي بلوغ متوسط العد الكلي للميكروبات الهوائيه ، الميكروبات القاولونيه ، المكورات العنقودية4.36 و 2.85 و 1.43 لوغاريتم10 لكل جرام للكفته المصنعه بدهون تحت الجلد ، مقارنة بـ 4.31 و 2.88 و 2.7 للكفته المصنعه بدهون الامعاء 4.53 و 2.88 و 2.5 للكفته المصنعه بدهون بيت الكلاوى.وقد اثرت فتره التخزين على العد البكتيرى للميكروبات الهوائيه حيث كانت فى ازياد خلال فتره التخزين بينما كانت الميكروبات القاولونيه ، المكورات العنقودية فى تناقص.

تم ملاحظه عدم وجود اختلاف فى معاير الجوده المختلفه عند استخدام الانواع المختلفه من الدهون الا انه وجد ان دهون تحت الجلد تحتوى على نسبه قليله من الدهون المشبعه و;كانت نسبه الفقد بها قليله عن الانواع الاخرى وهى الانسب فى الاستخدام فى التصنيع عن باقى الانواع الاخرى.